

May 12, 2021

Ex Parte Notice

Marlene Dortch
Secretary
Federal Communications Commission
45 L Street NE
Washington, DC 20554

**Re: Use of Spectrum Bands Above 24 GHz For Mobile Radio Services -
GN Docket No. 14-177**

**Texas Instruments Request for Waiver of Section 15.255(c)(3) for Vehicle
Radar Operation in the 57-71 GHz Band - Docket No. TBA**

**Faurecia Clarion Electronics Petition For Declaratory Ruling And Request
For Waiver of Section 15.255(c)(3) for Interactive Motion Sensing Devices -
Docket No. TBA**

**Husqvarna AB, Request for Waiver of Section 15.255 for Collision Avoidance
Radar - Docket No. TBA**

**Acconeer AB Request for Waiver of Section 15.255(c)(3) for Vehicle Radar
Operation in the 57-64 GHz Band - ET Docket No. 21-48**

**IEE Sensing, Inc. Request for Waiver of Sections 15.255(c)(2) and/or
15.255(c)(3) for In-Vehicle Radar Operation in the 60-64 GHz Band -
ET Docket No. 20-435**

**Brose North America, Inc. Request for Waiver of Section 15.255(c)(3) for In-
Vehicle Radar Operation in the 57-64 GHz Band - ET Docket No. 20-434**

**Tesla Inc. Request for Waiver of Section 15.255(c)(3) for Vehicle Radar
Operation in the 60-64 GHz Band - ET Docket No. 20-264**

**Infineon Technologies Americas Corp. Request for Waiver of Section
15.255(C)(3) for In-Vehicle Radar Operation in the 57-64 GHz Band -
ET Docket No. 20-263**

**Valeo North America, Inc. Request for Waiver of Section 15. 255(c)(3) for In-
Vehicle operation in the 57-64 GHz Band - ET Docket No. 20-121**

**Vayyar Imaging Ltd. Request for Waiver of Sections 15.255(b)(2) & (c)(3)
for Radars Used for Interactive Motion Sensing in the 57-64 GHz Band -
ET Docket No. 20-15**

Dear Madam Secretary:

On May 10, 2021, Alan Norman and the undersigned of Facebook, Carlos Cordeiro of Intel, and Dean Brenner, John Kuzin, and Bin Tian of Qualcomm met via teleconference with Ethan Lucarelli, Acting Legal Advisor to Acting Chairwoman Rosenworcel to discuss updating FCC Rule Section 15.255 that governs unlicensed use of the 60 GHz band.

Our companies discussed our support for the Commission adopting a Notice of Proposed Rulemaking to update FCC Rule Section 15.255 governing unlicensed use of the 60 GHz band. As explained in further detail in the attached filing in the above-referenced dockets,¹ to the extent the FCC proposes to revise this Part 15 unlicensed rule to allow radar operations within 57 to 64 GHz at higher power than presently permitted and with a 10% duty cycle in a 33 millisecond (“ms”) period, the agency should also propose to include a provision to ensure such radar operations do not completely occupy the 57 to 64 GHz band and inhibit communications applications, including latency-sensitive AR/VR/XR applications that also need fair access to this important unlicensed band.

We discussed that while we plan to continue to work toward a coexistence solution as part of the 60 GHz Coexistence Study Group, the waiver conditions that the agency has approved for certain radar systems do not ensure fair access to the spectrum for communications applications, including latency-sensitive AR/VR/XR applications. As a result, we are requesting the FCC to include a proposal to revise Rule Section 15.255 to correct this problem, which we do not believe was intended when the Commission fashioned the waiver conditions. The Commission also should include the proposed revision in any future waiver orders until the FCC rule is revised.

A long-term regulatory solution is needed to allow for continued technological innovation while ensuring reasonable coexistence of all technologies operating under FCC Rule Section 15.255. Our companies strongly believe that the FCC should preserve the usefulness of the entire 60 GHz band for latency-sensitive AR/VR/XR applications. The collection of waiver requests filed since the Commission’s December 31, 2018 waiver grant for the Soli radar system to operate in the 57 to 64 GHz band outside of Rule Section 15.255 confirms the urgent need for the agency to update its rules governing unlicensed use of the 60 GHz band.

Respectfully submitted,

/s/ Priscilla Delgado Argeris

Priscilla Delgado Argeris

Public Policy Manager

Facebook, Inc.

cc: Ethan Lucarelli

¹ See Ex Parte Letter of Facebook, Intel, and Qualcomm in GN Docket No. 14-177, *et al* (filed May 10, 2021)

Att.

Ex Parte Letter of Facebook, Intel, and Qualcomm in GN Docket No. 14-177 et al (filed May 10, 2021)

May 10, 2021

Ex Parte Submission

Marlene Dortch
Secretary
Federal Communications Commission
45 L Street NE
Washington, DC 20554

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Vayyar Imaging Ltd. Request for Waiver of Sections 15.255(b)(2) & (c)(3) for Radars Used for Interactive Motion Sensing in the 57-64 GHz Band - ET Docket No. 20-15

Dear Madam Secretary:

Facebook, Intel, and Qualcomm encourage the Commission to adopt a Notice of Proposed Rulemaking to update FCC Rule Section 15.255 governing unlicensed use of the 60 GHz band. As explained below, to the extent the FCC proposes to revise this Part 15 unlicensed rule to allow radar operations within 57 to 64 GHz at higher power than presently permitted and with a 10% duty cycle in a 33 millisecond (“ms”) period, the agency should also propose to include a provision to ensure such radar operations do not completely occupy the 57 to 64 GHz band and inhibit communications applications, including latency-sensitive AR/VR/XR applications that also need fair access to this important unlicensed band.

60 GHz Coexistence Study Group. As the FCC knows, for more than two years, our three companies have been working to develop a sharing proposal with companies seeking to operate radar systems in the 57 to 64 GHz band.¹ Along with these companies, we created the 60 GHz Coexistence Study Group for Communications and Radar and have been actively studying ways to achieve coexistence between radar and communication devices in the 57-64 GHz band.² The coexistence parameters this group has studied to support fair sharing of the 57-64 GHz band include better-defined duty cycle limits, maximum transmission on time and minimum transmission off time, operating bandwidth and channelization, Listen Before Talk (“LBT”), transmit power, and antenna gain.

While we plan to continue working with this group on a coexistence solution, we are compelled to inform the Commission that the waiver conditions the agency has approved for certain radar systems do not enable fair access to the spectrum for communications applications, including latency-sensitive AR/VR/XR applications. As a result, we are requesting the FCC to include a proposal to revise Rule Section 15.255 to correct this problem, which we do not believe was intended when the Commission fashioned the waiver conditions. The Commission also should include the proposed revision in any future waiver orders until the FCC rule is revised.

Loopholes with the Radar Waiver Conditions. There are two main issues with the duty cycle parameter in the Commission’s 60 GHz waiver decisions. The first issue is with the maximum transmission duration, which allows up to 3.3 ms of uninterrupted transmission time (*i.e.*, 10% duty cycle over 33 ms) that can interrupt communications and increase their latency because these FMCW radar systems transmit without any channel sensing.

The second issue relates to the duty cycle definition. Under the terms in the waiver decisions, a radar device can meet the 10% duty cycle limit with, for example, a 10 μ s transmission on time and a 90 μ s off time, and effectively block communications applications in the same room or same vehicle. Therefore, a 10% duty cycle limit on higher-powered radar by itself does not ensure the fair sharing of spectrum between radar and communications systems and permits a much higher effective duty cycle for radar systems that can prevent communications applications from accessing the medium for much longer periods of time. Thus, there is a need to better define the duty cycle terms for radar systems such that any transmission gap below such off-time limit is deemed to be part of the transmission on time.

Addressing the Loopholes. To address the above issues, we request that the FCC adopt the additional condition (#2 below) on any higher power radar systems it proposes to permit within the 57 to 64 GHz portion of the band, as set out in #1 below:

1. A radar device may operate in the 57-64 GHz band at a maximum +13 dBm EIRP, +10 dBm transmitter conducted output power, and +13 dBm/MHz power spectral density, so long as

¹ See Ex Parte Letter of Facebook, Intel, and Qualcomm in GN Docket No 14-177, *et al.* (filed Apr. 19, 2021).

² See Ex Parte Letter of Facebook, *et al.*, in ET Docket Nos. 20-121, 20-15, and 19-350 (filed July 1, 2020).

the radar device does not exceed a transmit duty cycle (*i.e.*, on-time/[on-time + off-time]) of 10% in any 33 ms interval (*i.e.*, the device will not transmit longer than a total of 3.3 ms).

2. Any radar off-time period between two successive radar pulses that is less than 2 ms shall be considered “on time” for purposes of computing the duty cycle.

This additional condition is necessary to ensure that radar devices do not transmit with an effective duty cycle greatly in excess of the 10% limit and thus lock out communications uses in the 57 to 64 GHz band.

Permanent Solution. In revising Rule Section 15.255, we believe the Commission also should require any company who received (or receives) a waiver to operate radar equipment at higher power than the rule presently permits be required to fully comply with the terms of any new rule as of its effective date. Wisely, the Office of Engineering & Technology Order approving limited waivers to operate radars in the 57-64 GHz band inside of vehicles advises entities receiving waiver authority to operate outside current FCC Rule Section 15.255 that they will be subject to any updates to that rule pursuant to a future Commission rulemaking.³

Additional Considerations for the NPRM. As our companies recommended in the attached presentation to the FCC’s Technological Advisory Council in August 2020, in proposing to revise the 60 GHz unlicensed rule, the FCC also should seek broad comment on updating Rule Section 15.255 and consider asking the following questions:

- Should FCC Rule Section 15.255 allow greater radiated power for radar applications than the current rule permits?
- What changes to the recent waiver parameters are needed to improve sharing with communications applications?
- Should the FCC require communications applications (and radar applications) to use a contention-based protocol?
- Should radar applications that perform LBT be allowed to use the same power levels as communications applications in this band?

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A long-term regulatory solution is needed to allow for continued technological innovation while ensuring reasonable coexistence of all technologies operating under FCC Rule Section 15.255. Our companies strongly believe that the FCC should preserve the usefulness of the entire 60 GHz band for latency-sensitive AR/VR/XR applications. The collection of waiver requests filed since the Commission’s December 31, 2018 waiver grant for the Soli radar system to operate in

³ See Vayyar Imaging Ltd. Request for Waiver of Section 15.255(c)(3) for Radars used for Interactive Motion Sensing in 57-64 GHz, ET Docket No. 20-51, *et al.*, Order, DA 21-407 at ¶ 52 (rel. April 14, 2021).

the 57 to 64 GHz band outside of Rule Section 15.255 confirms the urgent need for the agency to update its rules governing unlicensed use of the 60 GHz band.

Respectfully submitted,

/s/ Alan Norman

Alan Norman
Director, Public Policy
Facebook

/s/ Carlos Cordeiro

Carlos Cordeiro
CTO, Wireless
Intel

/s/ John Kuzin

John Kuzin
Vice President and
Regulatory Counsel
Qualcomm

Att.

August 17, 2020 TAC Presentation

60 GHz band: potential & coexistence challenges

Carlos Cordeiro, Intel Corporation

Bin Tian, Qualcomm Inc.

Alan Norman, Facebook

FCC TAC presentation
August 17, 2020

Introduction and goals

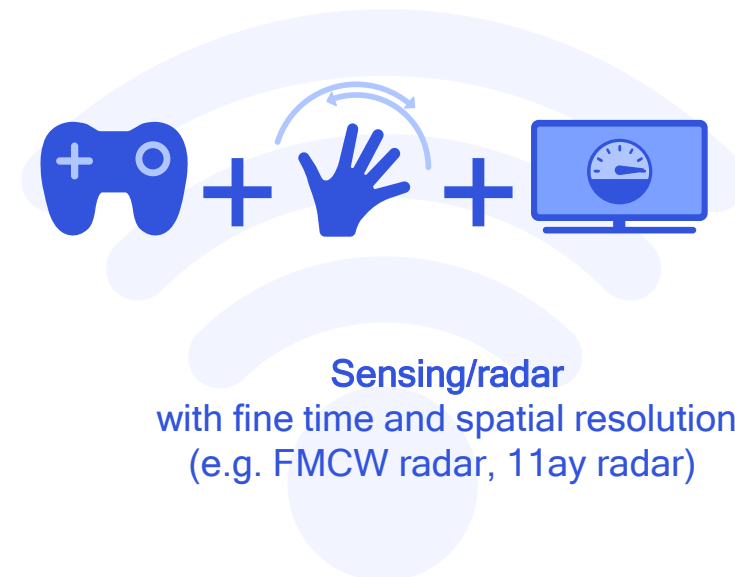
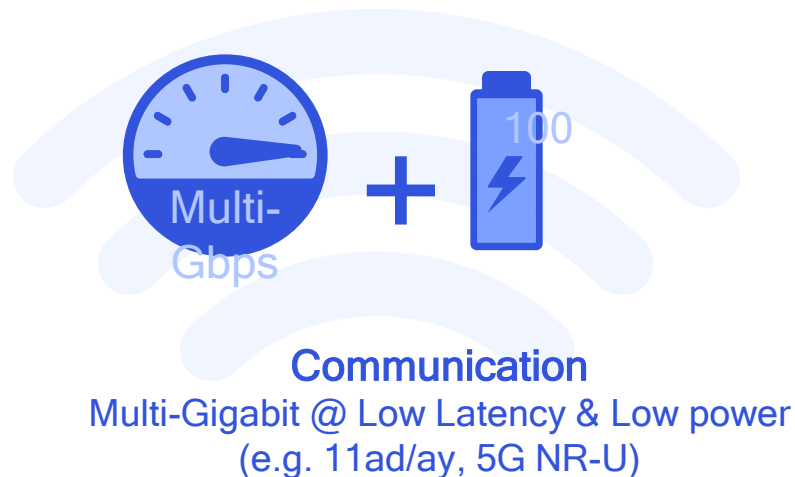
- In the US, the 60 GHz band (57-71 GHz) is regulated through an unlicensed regime
- The interest in 60 GHz is growing:
 - More and more 60 GHz capable devices commercially available from multiple vendors
 - Diverse set of usages (e.g., communication and radar/sensing)
 - New standards and technologies emerging
- So that use of this band can flourish given that different technologies are being deployed, it is becoming evident the need to update regulatory rules to enable proper coexistence in this band
- In this presentation, we focus on the usages, technologies and coexistence in this spectrum band, as well as recommend next steps in terms of regulatory action

Agenda

- 60 GHz band value proposition and usages
- Technologies in the 60 GHz band
- Coexistence in the 60 GHz band
- Summary of Current State of Affairs in the US
- Recommendations

60 GHz band value proposition and usages

- Value proposition of the 60 GHz band
 - Wide bandwidth: high throughput, high capacity, low latency, and fine time resolution
 - Small wavelength: enables antenna array on small footprint. Narrow beam leads to large capacity and fine spatial resolution.
- Two broad usage categories:



Communication use cases [6]

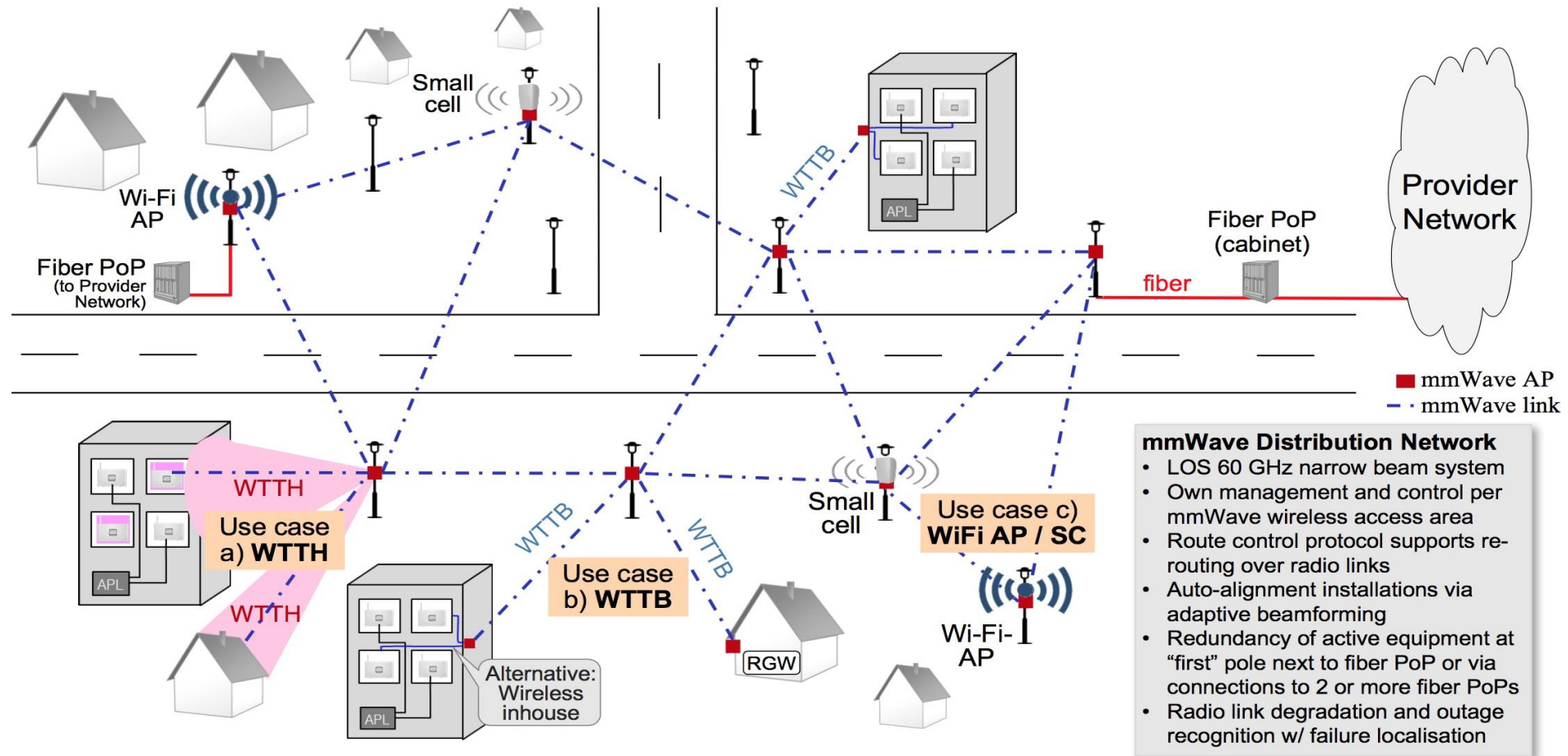
#	Applications and Characteristics	Indoor (I)/ Outdoor (O)	Propagation Condition	Throughput	Topology	Target overall latency
			LOS/ NLOS			
1	Ultra Short Range (USR) Communications	I	LOS only, <10cm	~10Gbps	P2P	<100ms
2	8K UHD Transfer at smart home	I	LOS with small NLOS ,<5m	>28Gbps	P2P	<5ms
3	Augmented Reality/Virtual Reality	I	LOS/NLOS, <5m	~20Gbps	P2P	<5ms
4	Data Center inter-rack connectivity -Indoor backhaul with multihop -backup interfaces for fiber optics failure	I	LOS only, <10m	~20Gbps	P2P/P2MP	<50ms
5	Video/Mass-Data Distribution/VoD -Multicast Streaming/Downloading for dense hotspots	I	LOS/NLOS, <100m	>20Gbps	P2P/P2MP	<100ms
6	Mobile Offloading and Multi-Band Operation - Stationary or low mobility for offloading	I/O	LOS/NLOS, <100m	>20Gbps	P2P/P2MP	<100ms
7	Mobile Fronthauling	O	LOS, <200m	~20Gbps	P2P/P2MP	
8	Wireless Backhauling: - Single hop and Multi-hop	O	LOS, <150m per hop	~2-20 Gbps	P2P/P2MP	<35ms
9	Wireless office docking	I	LOS/NLOS, <3m	~20Gbps	P2P/P2MP	<10ms
10	mmWave distribution network	O	LOS, < 300m	~1-20 Gbps	P2P/P2MP	< 2ms
11	Ultra short range wireless docking	I	LOS, 0.2m	~10 Gbps	P2P/P2MP	< 10ms

AR/VR in the 60 GHz band

- For best user experience, AR/VR needs wireless for immersive experience at high resolutions
- Multi-Gigabit speed for massive data exchange
 - Higher resolution (4k->8k) content at 60/90 fps
- Latency is critical
 - VR sickness is linked to high Motion-to-Photon (M2P) latency
 - Wireless link 99% packet latency has to be within few milliseconds



Wireless backhaul in the 60 GHz band



Sensing/radar use cases

- Fine time and spatial resolution achievable in 60 GHz band enables broad radar and sensing applications [5]. Some examples are:



**Proximity
Detection**



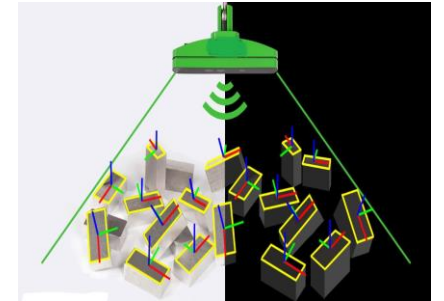
**Gesture
Recognition**



**Presence
Detection**



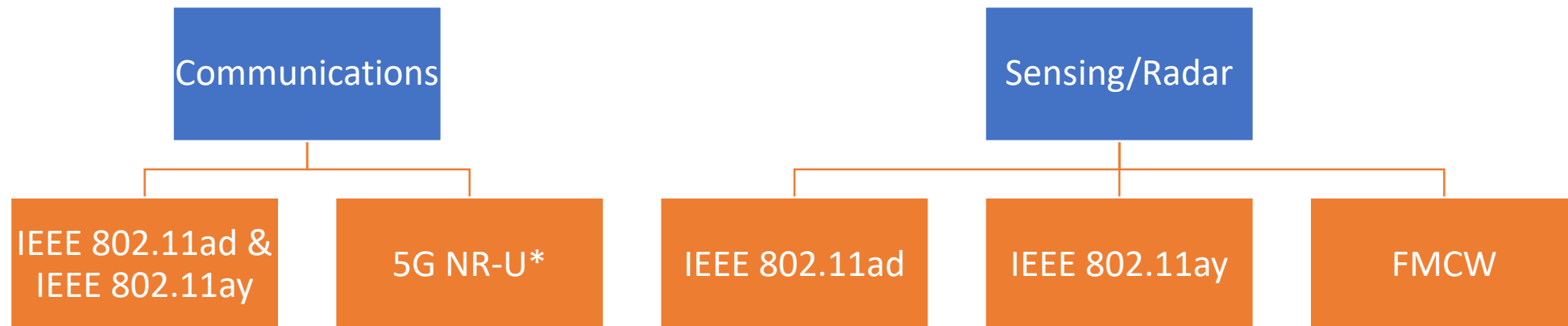
**Aliveness
Recognition**



**Robot
3-D Vision**

Taxonomy of 60 GHz technologies

- As described before, popular use cases of 60 GHz fall under two categories:
 - Communication: transmissions are used for the purpose of exchanging data
 - Sensing/radar: transmissions are used for the purpose of obtaining environment data
- The leading technologies employed to implement communication and sensing/radar usages, and considered in this presentation, are the following:



* NR-U operation in 60 GHz is in development in 3GPP. It will not be covered in detail in this presentation.

Technologies: IEEE 802.11ad

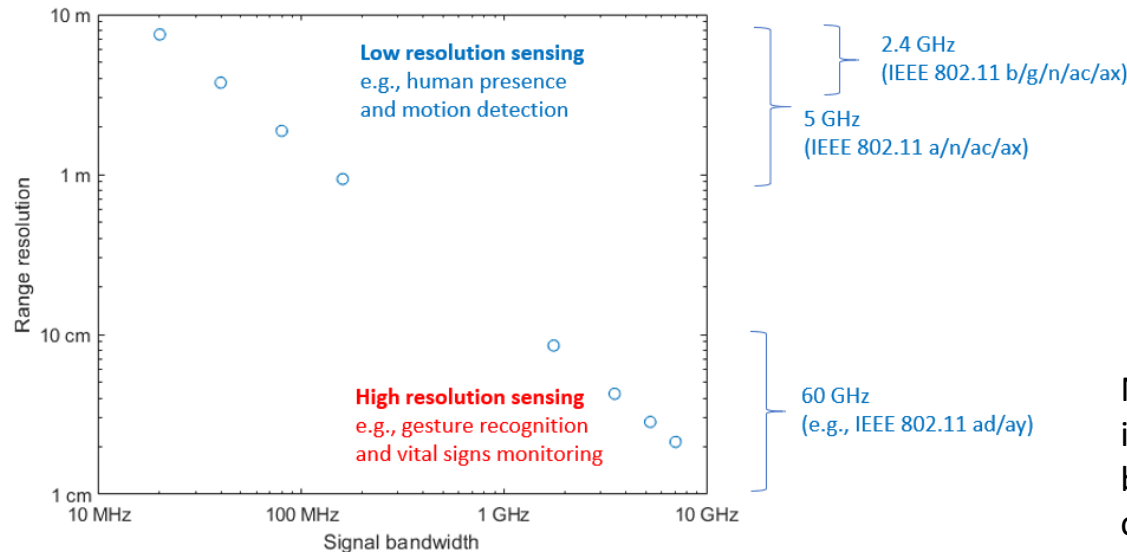
- First IEEE 802.11 amendment designed for the 60 GHz band [1], [2]
 - Ratified in December 2012
 - Addresses unique challenges arising from 60 GHz signal propagation and RF technology
 - PHY and MAC definitions that enable directional communications with electronic beam steering
- Key technical features:
 - Maximum data rate of 8 Gbps
 - 2.16 GHz channels, single-stream operation (SISO)
 - Medium access: Scheduled and contention access
 - Beamforming protocols: Sector level sweep (SSW) and beam refinement (BRP)
- Wi-Fi Alliance: WiGig certification
 - R1 released in 2016, R2 in 2018

Technologies: IEEE 802.11ay

- IEEE 802.11ay is the next generation standard after IEEE 802.11ad [3], [4]
 - Builds on top of and is backward compatible to 11ad
 - Supports rates in excess of 200 Gbps for indoor & outdoor usages
 - Expected to be ratified in late 2020/early 2021
- Key technical features:
 - Channel bonding: 2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channels
 - MIMO operation, up to 8 streams, and downlink multi-user (MU) transmissions
 - New medium access scheme for fixed wireless access applications
 - Time division duplex (TDD) service period
 - Supports Facebook Terragraph, multi-hop backhaul 60 GHz system for street level deployments
 - Enhanced beamforming protocols, support to multi-channel operation and MIMO
- Wi-Fi Alliance: On-going 60 GHz Fixed Wireless certification program
 - <https://www.wi-fi.org/who-we-are/current-work-areas>

Technologies: 11ad/11ay-based sensing/radar

- Wide bandwidth of 11ad/ay signals offers the time-resolution necessary to support sensing/radar applications such as gesture recognition and vital signs monitoring.

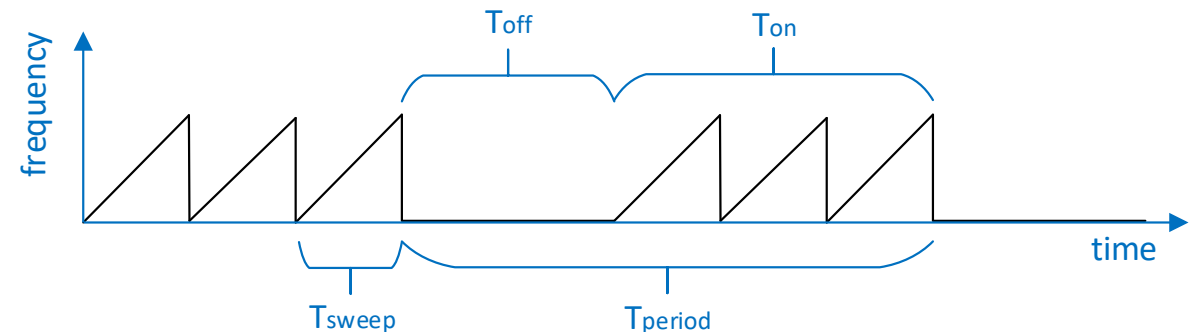


Note: Range resolution is taken to be inversely proportional to the signal bandwidth. Improved resolution can be obtained with advanced signal processing.

- Use of 11ad/ay technology to implement sensing/radar functionality is identified in the 11ay standard and has been publicly demonstrated for various applications.
- IEEE 802.11 has a study group on WLAN sensing that is expected to become a task group in Nov. 2020; the goal is to enhance the sensing capabilities of 11ad/ay technology and enable new usage models.

Technologies: FMCW

- Frequency-modulated continuous wave (FMCW) radars:
 - Signal frequency changes over time, typically in a sweep across a set bandwidth
 - Difference in frequency between the transmitted and received/reflected signal is determined by mixing both signals, producing a third signal that is measured to determine distance and velocity
 - Inexpensive, compact, and good range resolution
- Key operating parameters
 - Bandwidth: Determines range resolution
 - T_{sweep} : Determines maximum unambiguous velocity
 - T_{period} : Repetition period
 - T_{on} : Determines velocity resolution
 - $T_{\text{on}}/T_{\text{period}}$: Duty cycle

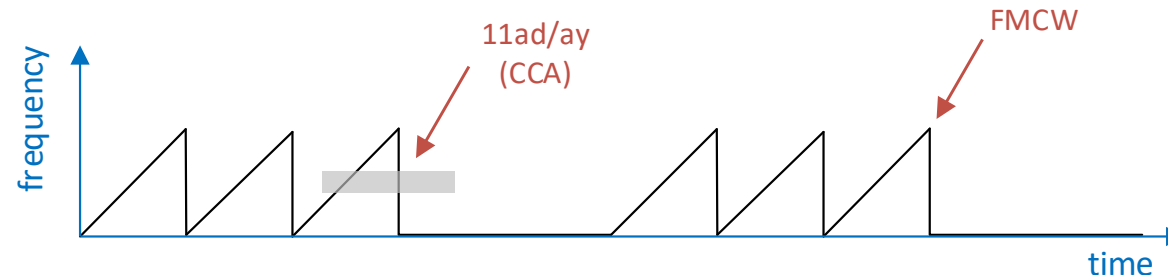


11ad/ay coexistence mechanisms

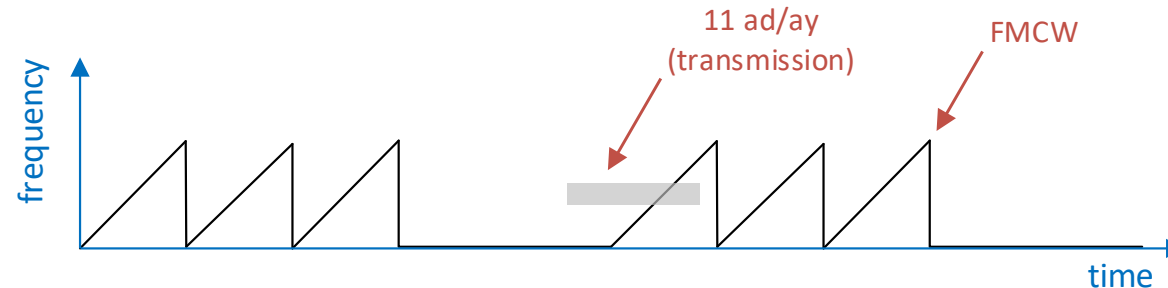
- As other IEEE 802.11 technologies, 11ad/ay defines a number of features that facilitate co-existence with itself and other systems, including:
 - Listen-before-talk (LBT)
 - Channelization and DFS
 - Transmit power control (TPC)
 - Beamforming
- How would 11ad/11ay coexist with FMCW transmissions?

Coexistence between 11ad/ay and FMCW

- Close operation of radar and 11ad/ay devices could lead to co-existence issues
- Example 1: 11ad/ay devices could be blocked (busy CCA) when accessing the channel
 - Multiple nearby 11ad/ay devices/networks could avoid interference by using different channels
 - However, FMCW transmissions may span the entire 60 GHz band



- Example 2: Reception of 11ad/ay signals could be interfered by radar transmission
 - If FMCW radar implementations do not perform CCA, radar transmissions may occur even if channel is used by other devices



Considerations on duty cycle

- The FCC waiver granted to Google Soli (FWCM) introduces a 10% duty cycle limit over any 33ms period to address coexistence issues in the 60 GHz band
- While this is a good step forward, duty cycle alone may not be adequate to satisfactorily address coexistence due to the following reasons:
 - **Max TX On Duration:**
 - The potentially long transmission time (3.3ms) will impact the ability of other systems to access the channel and may impact latency (e.g., AR/VR)
 - **Min TX Off Duration:**
 - In theory, a device can still satisfy the 10% duty cycle with 0.01us TX On Duration and 0.09us TX Off Duration
 - However, the very short gap between transmissions may not be able to be utilized by other nearby systems
 - Therefore, there may be a need to regulate Min TX Off Duration

Summary of Current State of Affairs in the US

- The current FCC 60 GHz unlicensed rules require updating because they do not account for the current and planned uses for this important band - as evidenced by many recent requests for waiver of the 60 GHz band rules
 - Low transmit power limit in current rule is insufficient to support current and future radar applications
- To promote adequate co-existence among multiple technologies in the 60 GHz band, the FCC should consider regulation of one or more of the following parameters:
 - TX power and antenna gain
 - Duty cycle
 - Maximum transmission on duration & Minimum transmission off duration
 - Listen before talk
 - Bandwidth and channelization

Recommendations

- The FCC should issue a Notice of Proposed Rulemaking reexamining the 60 GHz rules in 47 C.F.R. § 15.255 to improve sharing between communications uses and radar applications in the band
- Potential areas for public comment:
 - Should FCC rules allow greater radiated power for radar applications than currently permitted?
 - Should the parameters for Google Soli, for which other entities have filed “me-too” requests, be included in the rules?
 - What changes to the recent waiver parameters are needed to improve sharing with communications applications?
 - Should the FCC require communications applications (and radar applications) to use a contention-based protocol?
 - Should radar applications that perform LBT be allowed to use the same power levels as communications applications in this band?

References

- [1] IEEE Std 802.11-2016.
- [2] Nitsche, Cordeiro, Flores, Knightly, Perahia, and Widmer, "IEEE 802.11ad: Directional 60 GHz Communication for Multi-Gigabit-per-Second Wi-Fi," IEEE Commun. Mag., Dec. 2014.
- [3] IEEE P802.11ay/D5.0.
- [4] Ghasempour, da Silva, Cordeiro, and Knightly, "IEEE 802.11ay: Next-generation 60 GHz Communication for 100 Gbps Wi-Fi," IEEE Commun. Mag., Dec. 2017.
- [5] C. Silva, R. Arefi, C. Cordeiro, "The Need for Enabling Touchless Technologies," <https://www.intel.com/content/dam/www/public/us/en/documents/white-papers/the-need-for-enabling-touchless-technologies-whitepaper.pdf>
- [6] <https://mentor.ieee.org/802.11/dcn/15/11-15-0625-07-00ay-ieee-802-11-tgay-usage-scenarios.pptx>